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Development and Nutritional analysis of a fiber rich fruit concentrate

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Abstract
A phenomenal decrease in fiber content in the daily dietary patterns is a one of the leading causes of digestive disorders including various diseases associated with the upper as well as lower gastrointestinal tract. Laxatives are generally used for short periods of time until symptoms ease. Since most of the laxatives are synthetic in nature, the basic purpose of this study is to introduce fiber rich syrup which can act as a natural laxative. A fruit concentrate was developed incorporating dates, figs, pectin, ginger extract, barley water and wood apple as the main ingredients. The product was subjected to sensory evaluation and the most approved product was further biochemically tested for its nutritional composition. The product prepared showed high amounts of fiber, iron, magnesium and phosphorous as compared to the basic product making it a potential natural laxative.

Keywords: digestion, fiber, fruit concentrate, gastrointestinal disorders, nutrients

1. Introduction

Fiber is mainly a carbohydrate which functions in maintenance of a healthy digestive system. Apart from the above, dietary fiber also contributes to other processes, such as stabilizing glucose and cholesterol levels and prevention of cancer. Countries traditionally following high-fiber diets have shown reduced incidences of diseases such as bowel cancer, diabetes and coronary heart disease compared to others [1, 2, 3]. According to the recommendations of the Heart Foundation, adults should ideally consume approximately 25–30 gm of fiber daily. Children aged between four and eight years should consume 18 gm of fiber each day. Girls aged nine to thirteen; and fourteen to eighteen years need 20 gm and 22 gm of fiber per day respectively. Furthermore, boys aged nine to thirteen; and fourteen to eighteen years, need 24 gm and 28 gm of fiber per day respectively [4]. Disorders that can arise from a low-fiber diet include constipation, irritable bowel syndrome, diverticulitis, heart diseases as well as colon cancers. There are two categories of fibers; soluble and insoluble fiber, both of which are required to be consumed in one's daily diet. Soluble fiber include pectin, gums and mucilage, which are found mainly in plant cells. One of their major roles is to lower Low Density Lipoprotein (LDL) cholesterol levels [5]. Good sources of soluble fiber include fruits, vegetables, oat bran, barley, seed husks, flaxseed, psyllium, dried beans, lentils, peas, soy milk and soy products. Soluble fibers can also help in improving constipation. Insoluble fiber includes cellulose; hemicelluloses and lignin, their major role being addition of add bulk to feces and to prevent constipation as well as associated problems such as hemorrhoids. Popular sources of the above are wheat bran, corn bran, rice bran, the skins of fruits and vegetables, nuts, seeds, dried beans and wholegrain foods. Both types of fibers are beneficial to the body and most plant foods contain a mixture of them. According to previous studies, low fiber diet, hypothyroidism, excess use of laxatives as well as excess consumption of dairy products are some of the many reasons that lead to gastrointestinal discomfort [6]. Therefore in order to curb the unwanted circumstances, an attempt was made to introduce a natural laxative in the form of fiber rich syrup which may help in preventing gastrointestinal discomfort including constipation. The key ingredients used in the syrup were dates, figs, pectin, ginger extract, barley water and wood apple.

Dates being rich in both soluble and insoluble fiber ease the movement of bowels down the gastrointestinal tract [7]. Figs are known to make stool softer and facilitate digestion. Pectin has been documented to work with natural probiotic bacteria of the intestine to convert dietary fibers into a soothing coat for the irritated intestinal walls [8, 9]. Moreover, it adds bulk to the stool thereby helping in conditions of constipation [10]. Ginger extract being a natural laxative helps to promote bowel movement, and soothes the intestinal tract aiding in proper digestion and regular bowel movements. Barley being fiber rich also helps to prevent constipation and promote regularity for a healthy digestive tract [11]. Wood apple was added in the product in order to further enhance the fiber content apart from boosting the nutritional value. The health benefits of Beal Fruit or Wood Apple include relief from constipation, indigestion, peptic ulcer, piles, respiratory problems, diarrhea, and dysentery. It has also been shown to boost the immune system, fights off bacterial and viral infections, reduces inflammatory conditions, prevent cancer, increases milk production for nursing mothers, cures diabetes as well as increase ocular health [12, 13, 14]. It is also recommended as a remedy for digestive disorders including chronic dysentery. Hence a product was developed to fulfill the above requirements. The product developed is a fruit concentrate which can be consumed by all the age groups if they are prone to gastrointestinal discomfort. The laxatives available in the market generally contain artificial sweeteners which can

otherwise cause addiction and adverse health effects. Therefore, the product developed was made free from artificial sweeteners. Instead it contains natural sweetness due to the presence of dates, figs and wood apple. This property of the concentrate makes it a natural laxative making it safer and better suited to relieve digestion ailments.

2. Materials and Methods

2.1 Selection of the place

The preparation and evaluation process of the product was conducted in the Food & Nutrition laboratory of J.D. Birla Institute, Kolkata. The biochemical estimations of the product including protein, fat, carbohydrate, dietary fiber, crude fiber, iron, calcium, magnesium, phosphorous were carried out in the chemistry and instrumentation laboratory of J.D. Birla Institute, Kolkata and Qualissure laboratory, Kolkata.

2.2 Selection of the sample

The evaluation of the products with variations was done by 50 panel members belonging to the age group of 18-40 years. Source of all the ingredients present in the fiber rich syrup were collected from local departmental stores of Kolkata. The raw materials used to make the syrup were dates, figs, pectin, ginger extracts and barley water.

2.3 Product Development

Basic recipe of fiber rich syrup was chosen for development. The process for the preparation of syrup is given in the flow chart (Figure 1). All other variations of the product were prepared by modification of the basic syrup as tabulated in Table 1.

2.4: Sensory evaluation

Sensory evaluation of the different variations compared to the basic recipe was done by the 9- point hedonic scale method developed by David Peryam and colleagues by all the 50 panel members [15].

2.5 Biochemical estimation of protein

The protein content of the samples was measured by the Biuret method. Bovine Serum Albumin (BSA) (Lobachemie, India) at a concentration of 1mg/ml was taken as the standard protein solution. Standard protein solution of 0.2ml, 0.4ml, 0.6ml, 0.8ml and 1ml was taken in a test tube and the volume was made up to 1ml with distilled water. For the test samples, 1ml of test sample was taken in separate test tubes. 4ml of Biuret reagent was added to all the test tubes and incubated at room temperature for 30 minutes. Thereafter, the optical density was recorded using spectrophotometer at 550nm. The concentration of the protein in the unknown samples was determined using the standard curve.

2.6 Determination of fat content

The fat content was determined by the Soxhlet method. The samples were extracted with petroleum ether in the Soxhlet continuous extractor. Samples were dried; powdered and 5 gm of sample was weighed. They were placed in the middle part of Soxhlet apparatus. 150ml of petroleum ether was poured into the bottom flask and heat at 100 $\pm 2^0$C by the electrically controlled mantle heater. After extraction, the bottom flask with the residue was dried in an oven at 50-100°C. It was cooled and weighed to determine the fat content the following formula:

Fat content, percent = [100(B - C)]/A; where

A = Sample weight

B = Weight of flask after extraction

C = Weight of flask prior to extraction

2.7 Determination of Carbohydrate

Determination of carbohydrate was done by the Anthrone method. 100 mg of sample was taken in a boiling tube and hydrolysed by keeping it in a water bath for 3 hours with 5ml of 2.5N HCL. Thereafter, the sample was cooled to room temperature and neutralized with sodium carbonate until the effervescence seized. The volume of the sample mixture was made up to 100ml and centrifuged at 3000-4000g. The supernatant was collected and 1ml of aliquot was taken for analysis. To it was added 4ml of Anthrone reagent (Lobachemie, India). It was heated for 8 minutes in a boiling water bath after which the absorbance was measured in at 630nm. D- Glucose at a concentration of 1mg/ml was used as the standard carbohydrate for the estimation. The concentration of the carbohydrate in the sample was calculated using the standard curve.

2.8 Crude fiber analysis

The crude fiber content was determined by subjecting the sample to consecutive acid and alkali treatment followed by filtration. 10 gm of the syrup was taken and was boiled with 200 ml of sulphuric followed by 200ml of sodium hydroxide solution for 30 minutes. The residue obtained was washed with water and dried in a hot at oven at 150^0C. The dried residue was next ignited in a muffle furnace at 600-800°C. The loss in weight was determined and used to calculate the crude fiber content in the product.

2.9 Preparation of ash solution

The ash solution was prepared in order to carry out the mineral estimations. 20 gm of the sample was weighed, desiccated and placed in a muffle furnace at 600-800°C. The ash was weighed and divided equally for calcium, iron, phosphorus and magnesium estimations. The measured ash was dissolved in 5ml of 6M HCL solution and warmed over a water bath and filtered trice through Whatman No 1 filter paper (Lobachemie, India). This ash solution was used for estimation of calcium, iron, phosphorus and magnesium.

2.10 Determination of Calcium

Calcium content was estimated by the O- cresolphthalein Complexone (OCPC) Method, End point assay. OCPC combined with calcium at alkaline pH to form a purple coloured complex, the absorbance of which was measured at 578nm. The recommended volumes of kit reagents (Coral Clinical System, India) were added to the test tubes labeled as Blank, Standard and Test. The reaction mixtures were incubated at room temperature for 5 minutes followed by measurement of absorbance at 578nm. The concentration of calcium in mg/dl was determined by the following formula:

Calcium in mg/dl = [Absorbance of Test/ Absorbance of Standard] X 10

2.11 Determination of Iron
Determination of Iron was done by Ferrozine method where the Fe (II) ions reacted with Ferrozine to form a violet coloured complex. The recommended volumes of kit reagents (Coral Clinical System, India), buffer solution, colour reagent and standard solutions were added to the test tubes labeled as Blank, Standard and Test. The reaction mixtures were incubated at room temperature for 5 minutes followed by measurement of absorbance at 578nm. The concentration of iron in the sample was determined by the following formula:
Iron (µg/dL) = [Absorbance of Test/ Absorbance of Standard] X 200
Iron (µM) = [Absorbance of Test/ Absorbance of Standard] X 35.8

2.12 Determination of Phosphorous
Phosphorous content was determined by Colorimetric Method. Phosphorous is a form of phosphate reacted with ammonium molybdate to form a complex called ammonium phosphomolybdate. The complex was reduced by stannous chloride. The intensity of the colour after reduction was directly proportional to the concentration of phosphorous and was measured colorimetrically at 700 nm with the help of photoelectric colorimeter.

2.13 Determination of Magnesium
Estimation of magnesium was carried by EDTA titration method at pH 10 against Eriochrome Black T until colour changed to blue. The titer values obtained were used to calculate the magnesium concentration with reference to a standard magnesium solution.

2.14 Dietary fiber and Energy content
Dietary fiber and energy content of the samples were calculated using the Indian Council of Medical Research (ICMR) table. All results were expressed per 100 gm of the sample.

2.15 Shelf life study
The developed food product was stored in two different storage conditions *viz;* room temperature (25^0C) and refrigeration temperature (4^0C) to check the shelf life. The product was checked for sensory parameters after a span of 5 days and 12 days.

2.16 Analysis of Data
The data was tabulated and organized according to the requirement for appropriate analysis. The results were measured as mean±s.e.m of ≥3 individual experiments. The results were represented in the form of tables and bar graphs.

3. Results & Discussion
3.1 Product development and variations
In order to prepare a fiber rich fruit concentrate, date syrup was used as the basic product. Thirteen different variations were made incorporating different combinations and proportions of fiber rich ingredients such dates, figs, pectin, ginger extract, barley water and wood apple into the date syrup. The products were designated as product A-M as tabulated in table 1 along with their respective compositions.

3.2 Sensory Evaluation
The basic recipe and all the fortified product variations were assessed by 50 panel members using the 9- point hedonic scale test method for sensory parameters. After the assessment, it was found that product M containing 40ml of dates syrup, 10ml of figs paste, 1gm of pectin, 0.25gm of ginger extract, 10 ml of barley water and 10 ml of wood apple juice scored higher in all sensory parameters including appearance, colour, taste, texture and odour amongst all variations as compared to the basic syrup (table 2). The scores for product M were 8.5, 8.5, 8.3, 8.2 and 8.2 versus 7.4, 6.3, 7.8, 6.1 and 8.2 of the basic recipe for appearance, colour, taste, texture and odour respectively (figure 2). Product A was partially accepted by the panel members because of its well balanced taste and consistency. Products B and C was not appreciated by the panel members because of their increased sweetness and thick consistency. Moreover, Product D displayed less acceptability by the panel members because of the unchanged appearance, taste and consistency as compared to the previous product (product C). Products E and F showed higher acceptance compared to D because of their improved taste, odour and appearance versus the former. Due to bitter taste and strong odour of the ginger extract as well as the thick consistency due to barley water, products G, H, I, K and L were not approved by the panelists. However, Product M was comparatively highly accepted by the panel members amongst all variations as they were satisfied with all sensory parameters of this product compared to the others. Therefore, product M was the most approved variation with an overall rating of 9 compared to the basic syrup that scored 7 (figure 2). This product was further used for all biochemical estimations with respect to the basic syrup.

3.3 Estimation of food macromolecules and energy
After evaluation for the sensory parameters, product M was biochemically assessed in order to study its nutritional implications. The syrup was estimated for energy, carbohydrate, fat as well as protein content compared to the basic date syrup. The energy content of the basic product was estimated to be 158.5 kcal whereas the approved product contained 191.3 kcal per 100 gms of the product which was comparatively higher than the basic product due to the addition of energy dense ingredients such as figs, ginger extract, pectin extract, barley and wood apple (figure 3A). It was also observed that the product M contained increased carbohydrate content compared to the basic date syrup due to the presence of barley which belongs to the family of cereals (figure 3B). Moreover, the fortified product showed a fat content of 7.5 gm% compared to 5.4 gm % for the basic product (figure 3C). Furthermore, product M also displayed an increased amount of protein with respect to the basic product. The presence of figs, pectin extract, ginger extract, barley water and wood apple juice contributed to the increased protein content of the above (figure 3D).

3.4 Estimation of fiber content
Since the products were prepared as an attempt to relieve gastrointestinal discomfort, estimation of fiber content was carried out. Both the crude fiber as well as the dietary fiber content of the variations was assessed. The approved product

manifested 5.21 gm% and 19.41µg of crude fiber and dietary fiber content respectively compared to 3.16 gm % and 12µg of crude fiber and dietary fiber content for the basic product (figure 4A and 4B). The presence of fiber rich components including figs, ginger extract, barley, pectin and wood apple may have resulted in the increased fiber percentage of product M.

3.5 Estimation of mineral content

The products were assayed for minerals like iron, calcium, magnesium and phosphorus. The iron content of the basic product was seen to be lower than the approved product (figure 5A). Ingredients such as dates, figs, barley and wood apple contains a significant amount of iron thereby increasing the iron content of the approved product compared to the date syrup. Since our bodies cannot produce iron itself, one needs to consume sufficient amounts of iron as part of our daily diet. Product M displayed a calcium content of 74.2 mg% versus 63 mg % of the basic syrup due to the presence of dates, figs and wood apple in the former all of which contains good amounts of calcium (figure 5B). The magnesium content of basic product was 6.4 mg and that of the approved product was 9.23 mg due to the addition of various other ingredients in the approved product versus the basic syrup (figure 5C). Magnesium helps in water retention in the intestine which aids peristalsis, regularizes bowels and relieves constipation. Furthermore, the phosphorus content of basic product was seen to be 19.2 mg which was less than the approved product that contained 35.13 mg phosphorus. This may be because of to the presence of barley, dates and wood apple in the approved variation (figure 5D). Phosphorus supports a healthy metabolism and digestion of carbohydrates and fats by producing digestive enzymes that turn nutrients into useable energy, supporting a healthy metabolism. It causes an improved digestion, regulated excretion, protein formation, hormonal balance, improved energy extraction, cellular repair, optimized chemical reactions, and proper nutrient utilization in the body. Hence the approved variation displayed an increased content of minerals which generally promote a regular digestive functioning making it a significant source of natural laxative.

3.6 Determination of shelf life and cost of the product

The developed food products along with the basic recipe were stored in two different storage conditions *viz;* room temperature (25^0C) and refrigeration temperature (4^0C) to check the shelf life. The products were checked for sensory parameters after a span of 5 days and 12 days. Both the products displayed a pungent odour and sour taste after 12 days. The colour of the products also turned to be dark brown after the above duration. Moreover, the texture of the products showed thick consistency after 5 days followed by an unacceptable viscous appearance after a period of 12 days. Hence, it can be concluded that the sensory changes were not prominent enough after 5 days. The taste, odour and colour remained the same after 5 days in both room temperature and refrigerator. However after 12 days, all the sensory parameters appeared to be unacceptable even at the refrigeration temperature (table 3). Therefore, the product being a natural product without added preservatives must be consumed within 12 days of preparation. Furthermore, the cost of the approved variation was Rs 72.25 compared to Rs 16.7 per 100 gm of the basic product (table 4 and 5). The increased cost of the accepted product is due to addition of fiber and mineral rich ingredients in order to address digestive disorders. However, this can be considered as a cost effective alternative compared to other commercially available medications and neutraceuticals that address gastrointestinal ailments.

4. Conclusion

From the data derived, it can be concluded that the product coded as product M which contained 40ml of dates syrup, 10ml of figs paste, 1gm of pectin, 0.25gm of ginger extract, 10 ml of barley water and 10 ml of wood apple juice was highly acceptable by the panel members with respect to its appearance, taste, texture, colour, odour as well as overall ratings. The consistency as well as the after taste of the approved product was also appreciated by the panel members. The fiber rich fruit concentrate prepared contained comparatively more fiber and additional nutrients compared to the basic recipe. The iron, phosphorous, calcium and magnesium content of the approved product were also seen to be high in the developed product along with the other food macromolecules. Although the syrup is energy dense, it contains natural sweetness owing to the ingredients present. Hence, the developed product which has been fortified with various fiber rich ingredients may have the potential to cure certain gastrointestinal problems such as constipation, diarrhea etc. Moreover, the approved product apart from being a natural laxative without added sweeteners also is a cost effective option as compared to other neutraceuticals commercially available in the market.

5. Tables and figures

Table 1: Product variations

Product code	Additional Ingredient
Product A	40 ml dates syrup + 10 ml figs paste
Product B	30 ml dates syrup + 20 ml figs paste
Product C	25 ml dates syrup + 25 ml figs paste
Product D	40 ml dates syrup + 10 ml figs paste + 0.26gm pectin powder
Product E	40 ml dates syrup + 10 ml figs paste + 1gm pectin powder
Product F	40 ml dates syrup + 10 ml figs paste + 1gm pectin powder + 0.25 ginger extract
Product G	40 ml dates syrup + 10 ml figs paste + 1gm pectin powder + 0.5 gm ginger extract
Product H	40 ml dates syrup + 10 ml figs paste + 1gm pectin powder + 1gm ginger extract

Product I	30 ml dates syrup + 10 ml figs paste + 1gm pectin powder + 0.25 ginger extract + 5ml barley water
Product J	30 ml dates syrup + 10 ml figs paste + 1gm pectin powder + 0.25 ginger extract + 10 ml barley water
Product K	30 ml dates syrup + 10 ml figs paste + 1gm pectin powder + 0.25 ginger extract + 15 ml barley water
Product L	30 ml dates syrup + 10 ml figs paste + 1gm pectin powder + 0.25 ginger extract + 10 ml barley water + 5 ml wood apple juice
Product M	30 ml dates syrup + 10 ml figs paste + 1gm pectin powder + 0.25 ginger extract + 10 ml barley water + 10 ml wood apple juice
Product N	30 ml dates syrup + 10 ml figs paste + 1gm pectin powder + 0.25 ginger extract + 10 ml barley water + 15 ml wood apple juice

Table 2: Sensory Evaluation of different variations

Sensory parameters	Basic recipe	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Appearance	7.4	8.2	7.2	7.1	8	7.7	7.8	7	6	7.2	8.3	7.1	7.2	8.5	7.4
Colour	6.3	8.6	7.2	6.2	7.3	8.3	8	7.2	6.6	7.2	8.2	7.5	7.8	8.5	7.6
Taste	7.8	8.2	7.5	6.2	7.6	8.3	8	7.2	6.2	6.3	8.1	7.7	7.1	8.3	7.1
Texture	6.1	7.2	7.8	6.3	7.8	8	8.4	6.9	6.6	7.5	7.8	6.8	7	8.2	6.2
Odour	8.2	8	7.6	6.7	7.8	8.3	7.6	6.8	6.4	7.4	9.2	7.3	6.9	8.2	6.7
Overall rating	7	8.9	7.6	6.1	7.4	8.4	7.8	6.8	6.3	7.2	8.8	7.5	7.8	9	6.9

Table 3: Sensory parameters during shelf life study

Parameters	Basic product		Approved product	
	5 days	12 days	5 days	12 days
Taste	Sweet	Sour	Sweet	Sour
Odour	No change	pungent	No change	Pungent
Colour	Brown	Dark brown	Brown	Light brown
Texture	Thick	Viscous	Thick	Viscous

Table 4: Cost of the basic product

Serial No	Ingredients	Amount (gm)	Cost (Rs)
1.	Dates	50	16.7

Table 5: Cost of the approved product

S. No	Ingredients	Amount (gm)	Cost (Rs)
1.	Dates	40	13.2
2.	Figs	10	9.8
3.	Pectin powder	1	3.6
4.	Ginger extract	0.25	0.25
5.	Barley powder	10	33.4
6.	Wood apple	10	12.5
Total			72.75

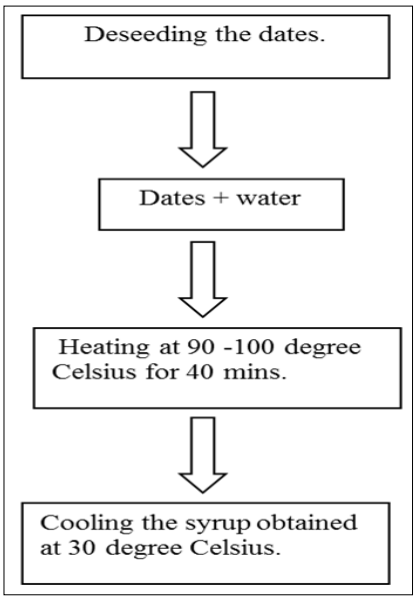

Fig 1: Preparation of the basic product

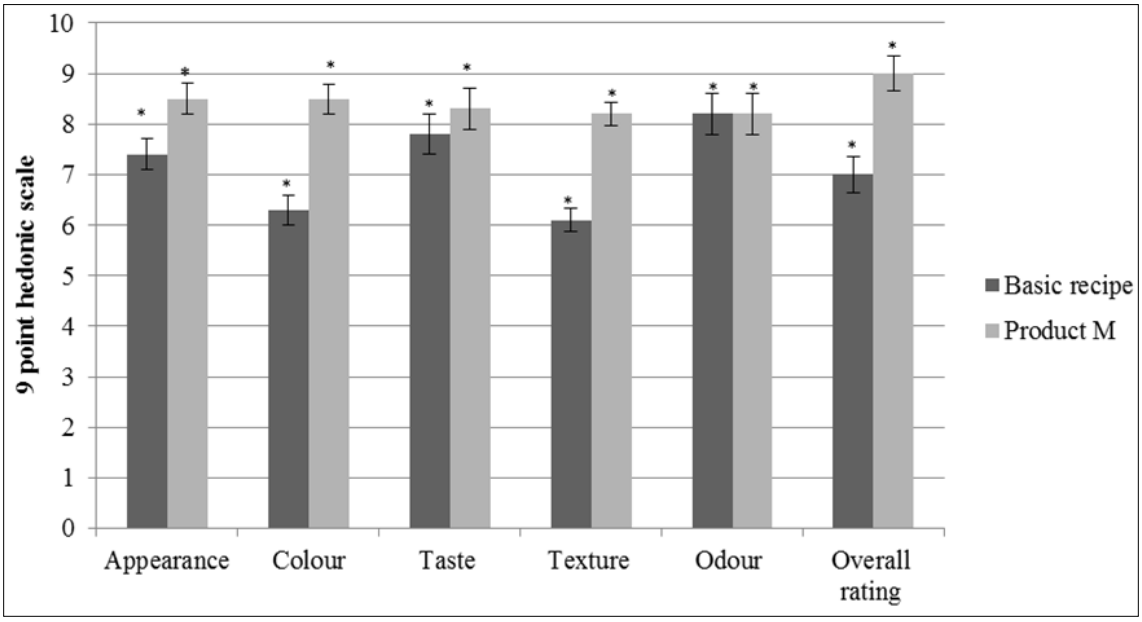

Fig 2: Sensory evaluation

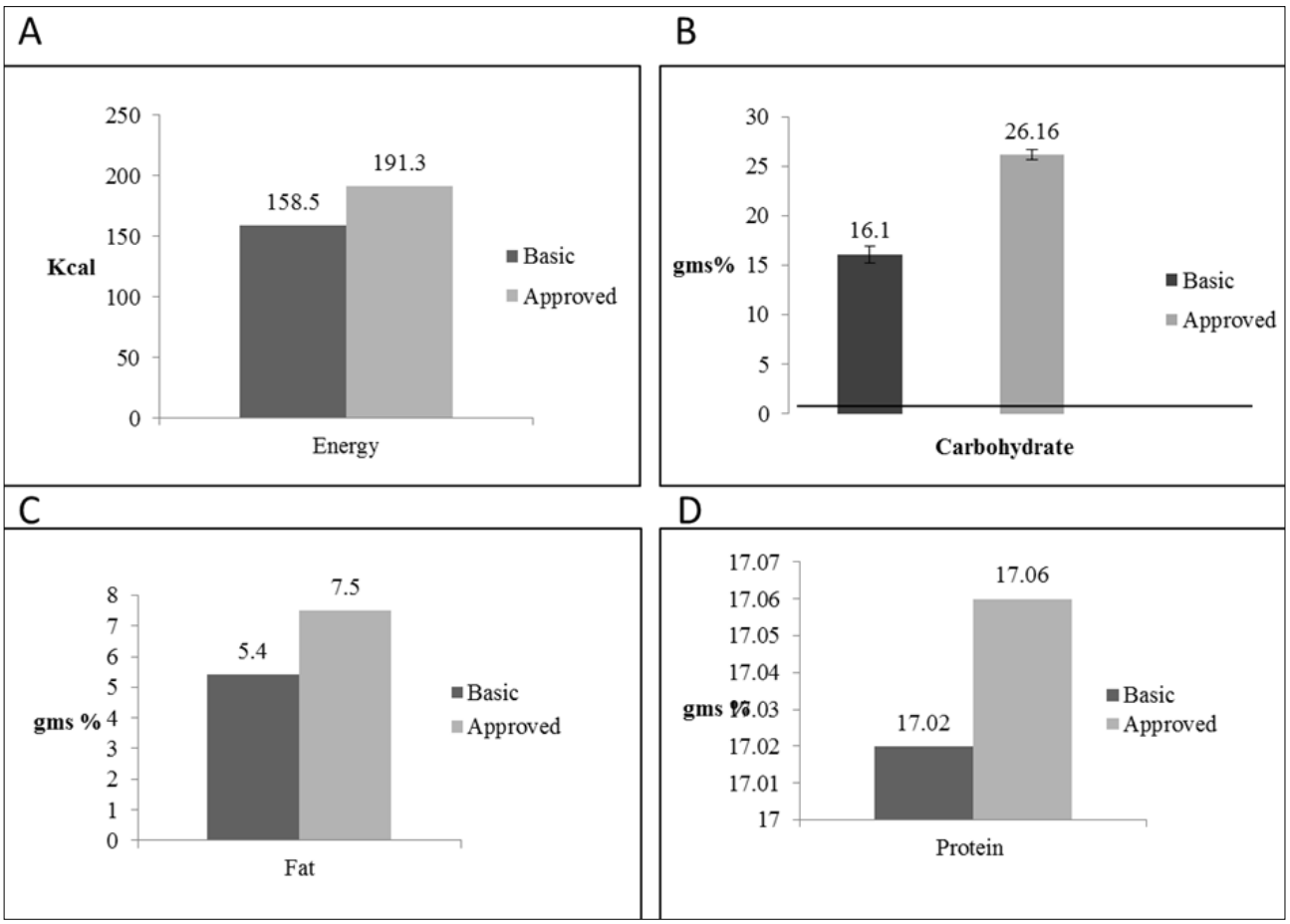

Fig 3: Estimation of food macromolecules and energy

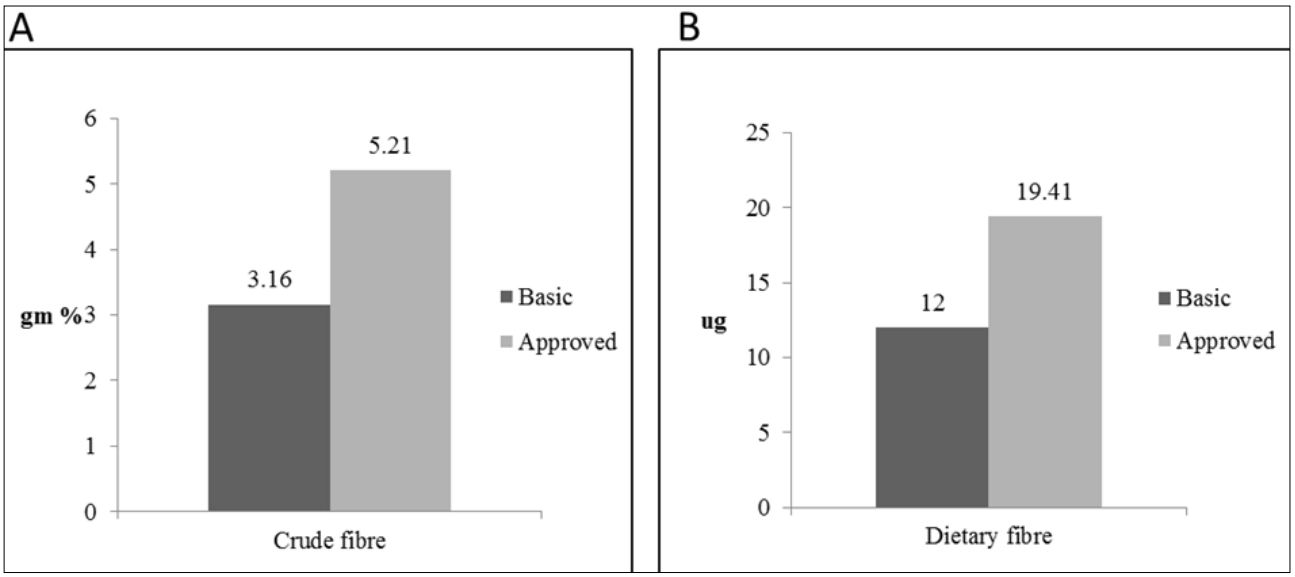

Fig 4: Estimation of fiber content

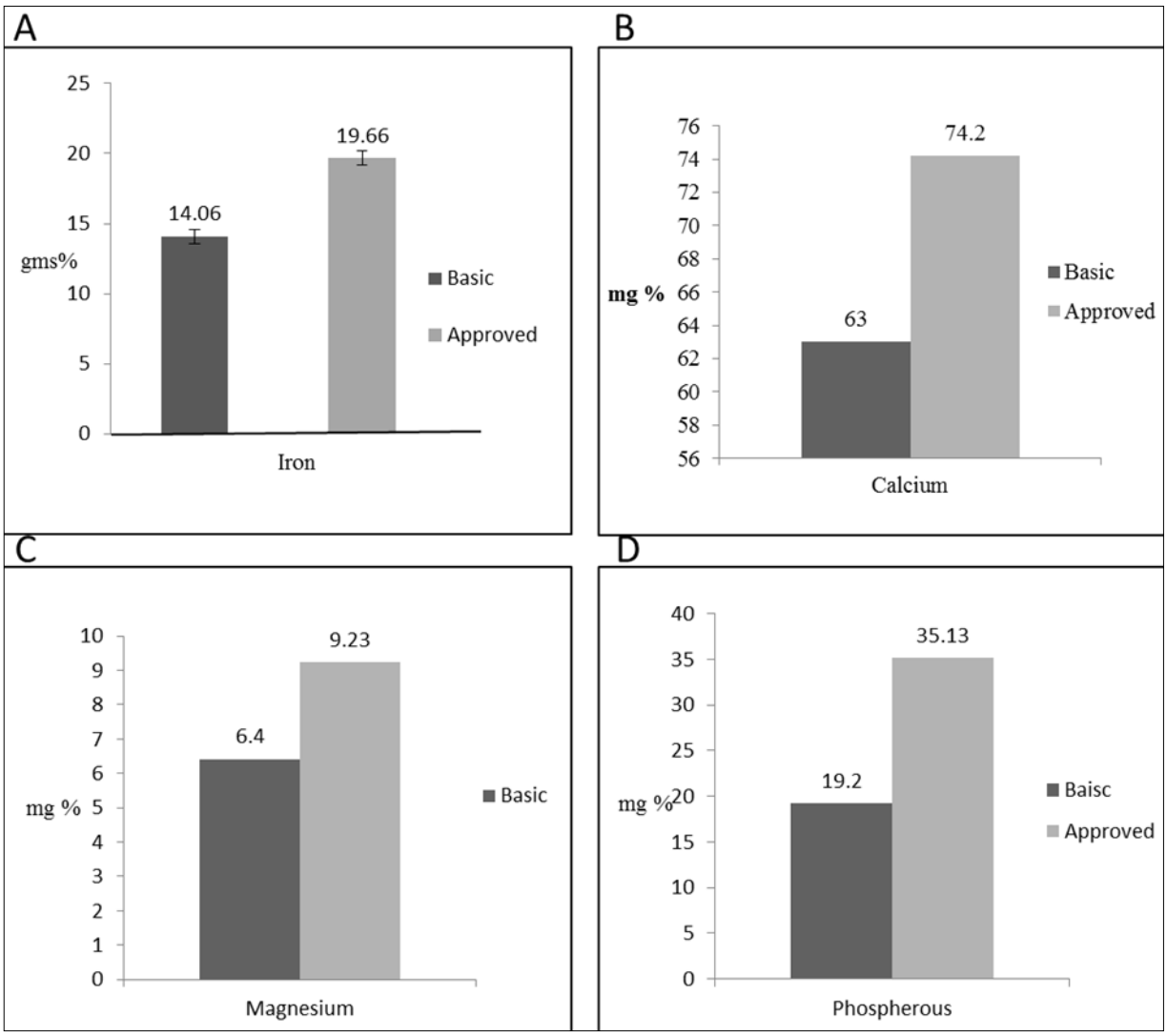

Fig 5: Estimation of mineral content

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